RonanRx
PERSONALIZED MEDICINE

CLINICAL MONOGRAPH · ANTIOXIDANT & MITOCHONDRIAL

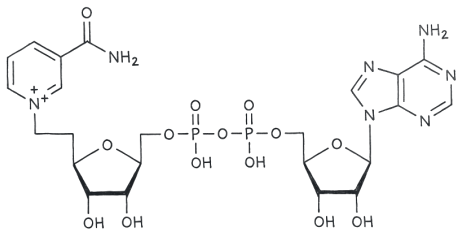
NAD+ / NMN

Nicotinamide adenine dinucleotide for cellular energy support

NAD+ stands for nicotinamide adenine dinucleotide. It is a small molecule that every cell in the body uses to convert food into energy and to run repair and signaling pathways. Levels of NAD+ in most tissues decline with age, which is why it has become a focus of aging research.

There is no FDA-approved NAD+ drug. The B-vitamin niacin (Niaspan) is FDA-approved, but for cholesterol, not for raising NAD+. Two newer precursors, nicotinamide riboside (NR, sold as NIAGEN) and nicotinamide mononucleotide (NMN), are sold as supplements [martens2018; yoshino2021]. Oral NR and NMN reliably raise blood NAD+ levels in clinical trials, but their effects on outcomes like strength, metabolism, and aging biomarkers have been mixed [imai2014; covarrubias2021].

Intravenous NAD+ is sometimes marketed as a longevity or wellness drip. The published human evidence for IV NAD+ is limited to a single 6-hour infusion pharmacokinetic study plus case reports [grant2019]. RonanRx prepares compounded NAD+ under 503A only for patients with a documented clinical reason and a specific physician-directed protocol, not as a routine wellness product.



EVIDENCE POSTURE EMERGING

REVIEWED **2026-05-11**


State-licensed 503A


Pharmacist reviewed


Doctor led


Cold-chain ready


Patient choice preserved

Contents

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FOR CLINICIANS

NAD+ is an obligatory cofactor for hundreds of enzymatic reactions, including the electron-transport-chain dehydrogenases of oxidative phosphorylation and the NAD+-consuming enzymes, sirtuins (SIRT1, 7), PARPs, CD38/CD157, and SARM1 [imai2014; covarrubias2021]. Tissue NAD+ declines with age in human skin, brain, liver, skeletal muscle, and adipose, driven in part by upregulation of the CD38 NAD-glycohydrolase [massudi2012; camacho_pereira2016]. The therapeutic hypothesis is that restoring NAD+ via oral precursors (nicotinamide riboside, nicotinamide mononucleotide) or parenteral NAD+ supports sirtuin-dependent mitochondrial and metabolic homeostasis.

Human pharmacokinetic and safety data for oral NR are strongest. Trammell et al. (2016) [trammell2016] characterized oral NR bioavailability in mice and a single-ascending-dose human study, demonstrating dose-dependent elevation of blood NAD+. Martens et al. (2018) [martens2018] randomized healthy middle-aged and older adults to NR 1000 mg/day for 6 weeks and showed near-doubling of peripheral blood mononuclear cell NAD+ with good tolerability. Conze et al. (2019) [conze2019] reported an 8-week placebo-controlled trial of NR (NIAGEN) up to 600 mg/day in adults with overweight, with sustained NAD+ elevation and no safety signal. Remie et al. (2020) [remie2020] randomized adults with obesity to NR 1000 mg/day for 6 weeks: NAD+ rose, body composition shifted modestly, but insulin sensitivity did not improve. Dollerup et al. (2020) [dollerup2020] showed no change in mitochondrial respiration in skeletal muscle of obese insulin-resistant men on NR 1000 mg/day for 12 weeks. NR has been tested in early Parkinson disease (NADPARK; Brakedal et al. 2022) [brakedal2022] with brain NAD+ rises detected on MRS.

NMN trials are smaller but consistent on PK. Yoshino et al. (2021) [yoshino2021] randomized 25 prediabetic postmenopausal women to NMN 250 mg/day for 10 weeks: muscle insulin sensitivity improved on hyperinsulinemic-euglycemic clamp, the first positive metabolic endpoint in a human NMN trial. Igarashi et al. (2022) [igarashi2022] tested NMN 250 mg/day for 12 weeks in healthy older men and showed blood NAD+ elevation with modest gains in muscle function. Pencina et al. (2023) [pencina2023] tested MIB-626 (a microcrystalline NMN polymorph) in middle-aged and older adults: dose-dependent NAD+ elevation in whole blood and PBMCs. Mehmel (2020) [mehmel2020] reviews the current NR therapeutic landscape.

IV NAD+ is the compounded route most relevant to RonanRx 503A practice. The only published peer-reviewed human PK study is Grant et al. (2019) [grant2019], a 6-hour infusion pilot in 11 healthy adults showing plasma NAD+ rise and urinary metabolite signature. Otherwise the literature is anecdotal case-series. RonanRx treats IV/IM/SC NAD+ as Tier-3 emerging evidence: legitimate when patient and physician have a specific protocol context (e.g., addiction-medicine-adjacent protocols, post-acute recovery, documented clinician-supervised use), not as DTC longevity marketing.

Why Personalized NAD+ / NMN

There is no FDA-approved NAD+ product. Every clinical use of NAD+ itself is compounded, and the trials that exist were each built around one route at one dose for one population. Trammell's oral NR pharmacokinetics, Yoshino's 250 mg oral NMN in prediabetic women, Pencina's MIB-626 polymorph, and Grant's single 6-hour IV NAD+ infusion in 11 healthy adults do not converge on a shared dosing schema. They tell you that blood NAD+ rises with supplementation. They do not tell you what dose, what route, or what cadence fits a specific patient with a specific clinical question, a specific tolerance for infusion-related flushing or chest tightness, and a specific reason their physician is reaching for this molecule at all.

Route and dose are the two axes a compounding pharmacy can move on for NAD+ specifically. IV infusion delivers a measured load over hours and lets the prescriber titrate by infusion rate when patients flush, feel pressure, or get nauseated. Intramuscular and subcutaneous injection trade peak for tolerability and let patients self-administer between clinician visits. Intranasal delivery is sometimes used when the target is CNS uptake without an infusion appointment. Oral capsules of NR or NMN sit in a different regulatory bucket as supplements, not 503A compounded drugs, but they remain an option in a layered protocol. Strength, frequency, and preservative profile all adjust to the patient. None of that flexibility lives in a manufactured product, because no manufactured product exists.

This is what pharmacy looked like before mass manufacturing arrived, and for NAD+ it is the only arrangement available. A prescriber writes the order for a named patient with a documented clinical reason. A licensed pharmacist prepares it. Modern sterility, ingredient sourcing, and traceability discipline keep the older model honest.

Quick Facts About NAD+ / NMN

Category: Cellular cofactor / redox coenzyme; precursors are vitamin B3 derivatives

Active ingredient: Nicotinamide adenine dinucleotide (NAD+) itself, or its precursors nicotinamide riboside (NR) and nicotinamide mononucleotide (NMN); related vitamin-B3 forms include niacin (nicotinic acid) and nicotinamide

FDA-approved branded forms: No FDA-approved NAD+, NR, or NMN drug product exists. Niacin (nicotinic acid) is FDA-approved as Niaspan for dyslipidemia; nicotinamide is sold OTC. NR (NIAGEN) is marketed as a GRAS dietary supplement, not a drug.

Routes used clinically: Oral capsule (NR, NMN, nicotinamide), intravenous infusion (compounded NAD+), and intramuscular or subcutaneous injection (compounded NAD+)

Evidence posture: Emerging. Small-to-modest randomized trials of oral NR and NMN show that NAD+ blood levels rise with supplementation; clinical endpoint effects are mixed. IV NAD+ has a single published pharmacokinetic pilot and otherwise rests on case-series and anecdotal use.

FDA-approval status: Not FDA-approved as NAD+, NR, or NMN drug products. Compounded IV/IM/SC NAD+ is a 503A patient-specific preparation; oral NR/NMN are dietary supplements outside the drug pathway.

Compounded under: 503A, patient-specific prescription only, with a documented clinical reason; not a direct-to-consumer longevity product

Important framing: The published human evidence for IV NAD+ in clinical use is essentially anecdotal/case-series, a single 6-hour infusion PK study (Grant 2019) is the principal peer-reviewed reference. RonanRx compounds NAD+ when the patient and physician have a specific protocol context, not as a DTC longevity product.

SPECIALS: PATIENT-SPECIFIC PRESCRIPTION ONLY

NAD+ / NMN described in this monograph is a 503A compounded preparation. Every dose is made on a prescription, for a named patient, by a licensed pharmacist. It is not a stocked, mass-manufactured product.

- **Made to order, not off a shelf.** No batch sits in a warehouse waiting for buyers. Your prescription triggers the prep.
- **Named-patient label.** The bottle carries one patient's name. The batch records carry one prescription.
- **Dose, strength, and route chosen for the patient.** A prescriber decides what gets compounded, not a manufacturer who set the strength for a trial population.
- **Licensed pharmacist on the hook.** A real person, with a license that can be pulled, signs off on every prep. State inspectors check the facility.
- **Compounded drugs are not FDA-approved.** They should not be evaluated using branded-drug trial data alone. Availability varies by state and prescribed medication.

How This Differs from a Research-Use-Only Website

A research-use-only website ships a vial from a warehouse. There is no prescription, no pharmacist, no facility inspection, and no way to recall the product if something is wrong with it. If the vial is mislabeled, contaminated, or under-potent, there is nobody whose license is at stake.

A 503A compounding pharmacy is the other thing. The doctor writes the prescription. A licensed pharmacist, whose name is on the label, prepares the medicine in a facility the state inspects. If something goes wrong, there is a person and a license on the hook, and a documented chain of custody on every lot. That accountability is what makes it safe.

What is NAD+ / NMN?

Nicotinamide adenine dinucleotide (NAD+) is a dinucleotide built from a nicotinamide ring and an adenine ring connected by a pair of ribose phosphates [imai2014]. It exists in cells as the oxidized form (NAD+) and the reduced form (NADH); together they form a redox couple that drives the dehydrogenase reactions of glycolysis, the tricarboxylic acid cycle, fatty-acid oxidation, and oxidative phosphorylation. A phosphorylated form, NADP+/NADPH, supports anabolic reductions and the antioxidant glutathione cycle.

Beyond redox, NAD+ is consumed (not merely shuttled) by three major enzyme families: the sirtuins (SIRT1, 7), which catalyze NAD+-dependent protein deacetylation and other acyl-removal reactions; the poly-ADP-ribose polymerases (PARPs), which transfer ADP-ribose to target proteins during DNA-damage signaling; and the CD38/CD157 NAD-glycohydrolases, which cleave NAD+ to generate calcium-mobilizing second messengers [imai2014; covarrubias2021]. SARM1, the nicotinamide-mononucleotide-activated NADase, drives programmed axon degeneration. Because these enzymes consume the substrate, intracellular NAD+ is in constant flux and depends on biosynthetic resupply.

Mammalian NAD+ biosynthesis runs through three principal routes: the de novo (kynurenine) pathway from tryptophan; the Preiss, Handler pathway from nicotinic acid; and the salvage pathways from nicotinamide, nicotinamide riboside (NR), and nicotinamide mononucleotide (NMN) [imai2014]. NR and NMN are biosynthetic intermediates in the salvage route, and both have been developed as oral supplements intended to raise tissue NAD+. The vitamin B3 family, niacin (nicotinic acid), nicotinamide, and NR, provides the dietary feedstock for these pathways [belenky2007, bogan2008, tempel2007].

How NAD+ / NMN Works

NAD+ functions in two distinct modes inside the cell [imai2014]. As a redox coenzyme it accepts and donates a pair of electrons, cycling between NAD+ and NADH to drive ATP synthesis through oxidative phosphorylation. As a signaling substrate it is consumed by the sirtuin, PARP, and CD38 enzyme families, which cleave the high-energy nicotinamide-ribose bond to do work on target proteins or to generate second messengers.

Cellular NAD+ levels reflect the balance between biosynthesis (de novo, Preiss, Handler, and salvage routes) and consumption (sirtuins, PARPs, CD38, SARM1) [covarrubias2021]. When that balance shifts toward consumption, for instance with chronic DNA damage, inflammatory upregulation of CD38, or simple aging, total NAD+ declines and the NAD+-dependent enzymes lose substrate [martens2018]. The sirtuin-activation hypothesis proposes that restoring NAD+ rescues sirtuin function and downstream mitochondrial, metabolic, and stress-response benefits.

Oral NR and NMN raise blood and PBMC NAD+ levels in humans across multiple trials [igarashi2022; pencina2023]. The connection from blood NAD+ rise to tissue-level NAD+ and to clinical endpoints is less consistent: Brakedal et al [bonkowski2016] [conze2019]. (2022) showed brain NAD+ rises by 31P-MRS in early Parkinson disease patients on NR [brakedal2022], while several trials in metabolic disease have failed to show improvements in insulin sensitivity, mitochondrial respiration, or body composition despite blood NAD+ rises [remie2020, dollerup2020] [imai2014]. Yoshino et al. (2021) is the principal positive metabolic-endpoint trial in NMN, with improved muscle insulin sensitivity in prediabetic postmenopausal women [yoshino2021] [trammell2016].

Biological Role of NAD+ / NMN

NAD+ is one of the most abundant non-protein molecules in living cells. Tissue concentrations are in the micromolar range and turnover is rapid, on the order of minutes to hours depending on cell type. The dinucleotide sits at the intersection of metabolism (as the dominant redox carrier of glycolysis and oxidative phosphorylation) and signaling (as substrate for sirtuins, PARPs, and CD38) [imai2014].

The aging-relevant biology has three interlocking arms. First, mitochondrial function depends on the NAD+/NADH redox state; chronic NAD+ depletion compromises ATP synthesis. Second, sirtuin signaling integrates NAD+ availability with energy status: when NAD+ is plentiful, sirtuins deacetylate substrates that promote oxidative metabolism, stress resistance, and DNA repair [imai2014]. Third, CD38, the dominant NAD+-degrading enzyme in tissue, rises with age and inflammation, accelerating the decline [camacho_pereira2016, covarrubias2021]. The convergence of these arms is the framework that motivated the clinical development of NR and NMN as NAD+ precursors and the off-label use of IV NAD+ in compounded settings.

Detailed Mechanism of NAD+ / NMN

The biochemistry of NAD+ consumption underlies the aging hypothesis [covarrubias2021]. Sirtuins (SIRT1 nuclear, SIRT3 mitochondrial, and others) deacetylate transcription factors and metabolic enzymes including FOXO3, PGC-1α, p53, and acetyl-CoA synthetases; the reaction obligately cleaves NAD+ and releases nicotinamide [imai2014, imai_guarente2010, bonkowski2016]. PARP1 polyADP-ribosylates DNA-damage targets and chromatin proteins. CD38 hydrolyzes NAD+ to ADP-ribose or cyclic-ADP-ribose at the plasma membrane and in lysosomes; CD38 has emerged as the dominant NADase responsible for age-related tissue NAD+ decline, and selective inhibition with small molecules such as 78c restores tissue NAD+ and reverses age-related metabolic dysfunction in mice [tarrago2018, chini2018]. Each consumption event must be matched by biosynthetic resupply for steady-state NAD+ to be preserved.

The NAD+/sirtuin axis converges on mitochondrial biology. Mouchiroud et al. (2013) showed in C. elegans and mammalian cells that NAD+ repletion activates the mitochondrial unfolded protein response (UPR-mt)

and FOXO signaling via SIR-2.1, extending lifespan in worms [mouchiroud2013]. Cantó et al. (2012) demonstrated in mice that oral NR enhances oxidative metabolism via SIRT1/SIRT3 activation and protects against diet-induced obesity [canto2012] [covarrubias2021]. The framework that emerged, restore NAD+, reactivate sirtuin signaling, restore mitochondrial function, is the proximal motivation for human precursor trials.

Age-associated NAD+ decline is now documented in multiple tissues [covarrubias2021]. Massudi et al. (2012) measured NAD+, NADH, NAD/NADH ratio, and PARP activity across the human lifespan in skin samples and showed a clear decline with age, accompanied by rising oxidative stress markers [massudi2012]. Camacho-Pereira et al. (2016) traced age-related NAD+ decline in mouse tissues to upregulation of CD38, and demonstrated that CD38 knockout protected against the decline and against age-associated mitochondrial dysfunction in a SIRT3-dependent manner [camacho_pereira2016]. The Bonkowski, Sinclair commentary framed the implication: NAD+ does not run out, it is destroyed faster than it is replaced [bonkowski2016]. Brain-specific NAD+ decline and its role in neurodegeneration has been reviewed in detail [lautrup2019].

The biology of the precursors [covarrubias2021]. Nicotinamide riboside was identified as a distinct NAD+ precursor vitamin by Bieganowski and Brenner in 2004 [bieganowski2004], with Belenky et al. (2007) demonstrating that NR extends lifespan via Sir2 in yeast through Nrk and Urh1/Pnp1/Meu1 salvage pathways [belenky2007_cell]. NR enters the mammalian cell via equilibrative nucleoside transporters, is phosphorylated by NRK1/NRK2 to NMN, and adenylated by NMNAT enzymes to NAD+ [tempel2007, bogan2008]. NMN can enter cells via multiple routes including, in some tissues, the SLC12A8 transporter; intracellularly NMN is adenylated directly to NAD+. Nicotinamide can be recycled to NMN by NAMPT (the rate-limiting salvage enzyme), and nicotinic acid feeds the Preiss, Handler pathway. The de novo (kynurenine) route from tryptophan provides a minor but non-trivial input under most dietary conditions.

Pharmacologically, oral NR and NMN do not deliver intact NAD+ to tissues [covarrubias2021]. Liver and gut are the principal first-pass sites of conversion; a substantial fraction of administered NR is rapidly methylated to N-methylnicotinamide and excreted, raising the methyl-group sink concern that high-dose chronic precursor loading could compete with other methylation pathways [trammell2016]. The systemic NAD+ rise observed in whole blood and PBMCs reflects increased substrate supply rather than direct delivery of the dinucleotide; tissue-level uptake remains the principal pharmacological question. Elhassan et al. (2019) provided the first direct evidence that oral NR raises the intramuscular NAD+ metabolome in aged humans on biopsy, with concurrent transcriptomic anti-inflammatory signatures [elhassan2019].

IV NAD+, by contrast, infuses the intact dinucleotide. Grant et al. (2019) showed in a 6-hour infusion pilot that plasma NAD+ rises in a delayed and dose-dependent way, with parallel rises in NAD+ metabolites in plasma and urine [grant2019]; the kinetics suggest extensive extracellular metabolism of infused NAD+ to nicotinamide and downstream precursors, which may then be salvaged intracellularly [covarrubias2021]. Whether IV NAD+ confers a tissue-level NAD+ benefit distinct from oral precursor dosing has not been established in controlled human trials.

NAD+ / NMN Research History

NAD+ was discovered by Arthur Harden and William Young in 1906 as a 'cozymase' factor required for yeast fermentation; the structure was solved by Otto Warburg and Hans von Euler-Chelpin in the 1930s, and the connection to vitamin B3 (niacin) was made by Conrad Elvehjem in 1937 when nicotinamide was shown to resolve canine black-tongue disease. Niacin entered clinical use for pellagra by the early 1940s. The vitamin chemistry and biosynthetic pathways were worked out across the 1950s and 1960s [belenky2007, bogan2008].

Two pre-NAD-aging human dermatologic and immunologic precedents matter for the modern safety case. The European Nicotinamide Diabetes Intervention Trial (ENDIT) randomized 552 islet-autoantibody-positive first-degree relatives at risk for type 1 diabetes to nicotinamide vs placebo for a median 5 years and found no diabetes-prevention effect, but established long-term high-dose nicotinamide tolerability across a multi-year exposure [gale2004_endit]. The ONTRAC trial [chen2015_ontrac] randomized 386 patients with prior nonmelanoma skin cancers to oral nicotinamide 500 mg twice daily and showed a 23% reduction in new lesions [chen2015_ontrac], following earlier phase II actinic-keratosis trials [surjana2012] and consolidated in reviews of the dermatologic literature [snaidr2019].

The modern NAD+/aging story begins with Bieganowski and Brenner's 2004 identification of nicotinamide riboside (NR) as a distinct NAD+ precursor vitamin [bieganowski2004], followed by Belenky et al. (2007) showing NR extends lifespan via Sir2 in yeast [belenky2007_cell] and the structural characterization of the NR kinase enzymes (NRK1/NRK2) by Tempel et al. (2007) [tempel2007]. Imai and Guarente consolidated the sirtuin, NAD+ axis as a unifying framework in 2010 and 2014 reviews [imai_guarente2010, imai2014]. Mendelsohn and Larrick (2014) connected NAD+ restoration directly to reversible skeletal-muscle aging [mendelsohn2014]. Cantó et al. (2012) demonstrated NR-driven SIRT1/SIRT3 activation and protection from diet-induced obesity in mice [canto2012], and Mouchiroud et al. (2013) linked the NAD+/sirtuin axis to lifespan extension via the mitochondrial UPR in C. elegans [mouchiroud2013]. Mills et al. (2016) demonstrated that long-term oral NMN administration mitigated age-associated physiological decline across multiple organ systems in mice, providing the preclinical foundation for human NMN trials [mills2016]; Yoshino et al. (2011) had earlier shown that NMN treated diet- and age-induced diabetes in mice [yoshino2011]. The aging-NAD-decline mechanism was nailed to CD38 upregulation by Camacho-Pereira et al. (2016) [camacho_pereira2016], with the CD38 inhibitor 78c later proving the principle pharmacologically in aged mice [tarrago2018, chini2018]; brain-specific NAD+ decline became a separate review focus [lautrup2019].

Human translation of NR followed quickly. Trammell et al. (2016) first characterized oral NR pharmacokinetics in humans, including the methyl-group sink question raised by extensive N-methylnicotinamide excretion [trammell2016]. Airhart et al. (2017) added an open-label PK study [airhart2017]. Martens et al. (2018) ran the first chronic NR trial in healthy middle-aged and older adults

[martens2018]; Dollerup et al. (2018, AJCN) ran the first parallel-group RCT of NR in obese, insulin-resistant men with detailed safety reporting [dollerup2018], and Conze et al. (2019) confirmed long-term tolerability and NAD+ elevation in overweight adults [conze2019]. Elhassan et al. (2019) provided the first muscle-biopsy demonstration that NR raises the intramuscular NAD+ metabolome in aged humans [elhassan2019]. Remie et al. (2020) and Dollerup et al. (2020) tested NR in further metabolic-disease cohorts with mostly null endpoint findings despite NAD+ rises [remie2020, dollerup2020]. Jensen et al. (2022) found that NR plus pterostilbene did not accelerate muscle injury recovery in older adults [jensen2022]. Pirinen et al. (2020) reported the only positive functional-endpoint NAD+-repletion trial to date, niacin (not NR) restored systemic NAD+ levels and improved muscle performance in adult-onset mitochondrial myopathy [pirinen2020].

Human NMN translation has been slower but ongoing. Irie et al. (2020) reported the first single-dose human NMN safety study in Japanese men [irie2020]. Yoshino M et al. (2021, Science) reported the first positive metabolic endpoint with NMN in prediabetic postmenopausal women [yoshino2021]. Liao et al. (2021) showed dose-dependent aerobic-capacity improvement on NMN in amateur runners [liao2021]. Igarashi et al. (2022) replicated NMN tolerability and muscle-function gains in older Japanese men [igarashi2022]. Pencina et al. (2023) characterized the MIB-626 microcrystalline NMN polymorph [pencina2023]. Yamaguchi et al. (2024) extended the NMN safety profile to 12 weeks in middle-aged Japanese men [yamaguchi2024]. NMN is currently outside the US dietary-supplement pathway after the FDA's reclassification.

The Parkinson disease translation began with Brakedal et al.'s 2022 NADPARK trial [brakedal2022] and continued with Berven et al.'s 2023 NR-SAFE trial of high-dose NR (3000 mg/day) [berven2023]; a longer-duration efficacy trial (NO-PARK) is in progress. The cardiac NAD+ literature is largely preclinical: Diguet et al. (2018, Circulation) showed NR preserves cardiac function in a mouse model of dilated cardiomyopathy [diguet2018], and Peclat et al. (2024) extended CD38-inhibition cardioprotection to doxorubicin-induced cardiotoxicity [peclat2024]. The first peer-reviewed human PK data on IV NAD+, Grant et al. (2019), described a 6-hour infusion protocol in 11 healthy adults [grant2019]; this remains the principal published reference for IV NAD+ used in clinical compounding settings.

NAD+ / NMN Timeline

1906 • Harden and Young identify cozymase (later named NAD) as a yeast fermentation factor

1937 • Elvehjem identifies nicotinamide as the dietary factor preventing pellagra; niacin enters clinical use

1958 • Preiss and Handler describe the nicotinic-acid-to-NAD+ biosynthesis pathway

2004 • Bieganowski and Brenner (Cell) identify nicotinamide riboside (NR) as a third NAD+ precursor vitamin distinct from niacin and nicotinamide, establishing the conserved NRK salvage route [bieganowski2004]

2004 • Gale et al [gale2004_endit]. (Lancet) publish the ENDIT trial, nicotinamide 1.2 g/day for a median 5 years did not prevent type 1 diabetes but established long-term high-dose tolerability

2007 • Belenky et al [belenky2007_cell]. (Cell) demonstrate that NR extends Sir2-dependent replicative lifespan in yeast via Nrk and Urh1/Pnp1/Meu1 pathways

2007 • Tempel et al [tempel2007]. solve the structures of the NR kinase enzymes (NRK1/NRK2), defining the salvage step from NR to NMN

2007 • Belenky and Brenner review NAD+ metabolism in health and disease (Trends in Biochemical Sciences) [belenky2007]

2008 • Bogan and Brenner publish a molecular evaluation of NAD+ precursor vitamins in human nutrition (Annual Review of Nutrition) [bogan2008]

2010 • Imai and Guarente (Trends in Pharmacological Sciences) consolidate ten years of mammalian sirtuin biology [imai_guarente2010]

2011 • Yoshino et al [yoshino2011]. (Cell Metabolism) show NMN treats diet- and age-induced diabetes pathophysiology in mice

2012 • Cantó et al [canto2012]. (Cell Metabolism) demonstrate that oral NR enhances oxidative metabolism via SIRT1/SIRT3 and protects against high-fat-diet obesity in mice

2013 • Mouchiroud et al. (Cell) link the NAD+/sirtuin axis to lifespan extension via the mitochondrial UPR and FOXO signaling in C [mouchiroud2013]. elegans

2014 • Mendelsohn and Larrick (Rejuvenation Research) tie skeletal muscle aging directly to NAD+ depletion [mendelsohn2014]

2015 • Chen et al [chen2015_ontrac]. (NEJM), ONTRAC trial shows oral nicotinamide 500 mg twice daily reduces nonmelanoma skin cancers by 23% in high-risk patients

2012 • Massudi et al [massudi2012]. (PLoS ONE) document age-associated NAD+ decline and rising oxidative stress in human skin tissue

2014 • Imai and Guarente (Trends in Cell Biology) consolidate the NAD+, sirtuin axis as a unifying framework for aging biology [imai2014]

2016 • Camacho-Pereira et al [camacho_pereira2016]. (Cell Metabolism) show that CD38 dictates age-related NAD+ decline through a SIRT3-dependent mechanism

- **2016** • Bonkowski and Sinclair (Nature Reviews Molecular Cell Biology) review NAD+ and sirtuin-activating compounds in aging [bonkowski2016]
- **2016** • Mills et al [mills2016]. (Cell Metabolism) demonstrate that long-term NMN administration mitigates age-associated physiological decline in mice
- **2016** • Trammell et al [trammell2016]. (Nature Communications) characterize oral NR pharmacokinetics in mice and humans, first human PK study of an NAD+ precursor
- **2017** • Airhart et al [airhart2017]. (PLoS ONE) publish an open-label PK study of NR in healthy adults
- **2018** • Martens et al [martens2018]. (Nature Communications), first chronic NR trial in healthy middle-aged and older adults: 1000 mg/day for 6 weeks roughly doubles PBMC NAD+ with good tolerability
- **2018** • Yoshino, Baur, and Imai (Cell Metabolism) review the biology and therapeutic potential of NMN and NR as NAD+ intermediates [yoshino2018]
- **2018** • Dollerup et al [dollerup2018]. (Am J Clin Nutr), first parallel-group RCT of NR 1000 mg twice daily in obese, insulin-resistant men: no insulin-sensitivity benefit despite NAD+ rise; primary safety dataset
- **2018** • Diguet et al [diguet2018]. (Circulation), NR preserves cardiac function in a mouse model of dilated cardiomyopathy; principal preclinical cardiac signal
- **2018** • Tarragó et al [tarrago2018]. (Cell Metabolism), CD38 inhibitor 78c reverses age-related tissue NAD+ decline in aged mice, establishing CD38 inhibition as an alternative to precursor loading
- **2019** • Conze et al [conze2019]. (Scientific Reports) report an 8-week randomized placebo-controlled trial of NIAGEN (NR) up to 600 mg/day in adults with overweight, sustained NAD+ elevation and clean safety
- **2019** • Elhassan et al [elhassan2019]. (Cell Reports), first muscle-biopsy demonstration that oral NR raises the intramuscular NAD+ metabolome in aged humans, with anti-inflammatory transcriptomic signatures
- **2019** • Snaidr, Damian, Halliday (Experimental Dermatology) review nicotinamide for skin-cancer chemoprevention and photoprotection [snaidr2019]
- **2019** • Grant et al [grant2019]. (Frontiers in Aging Neuroscience) publish the first peer-reviewed pharmacokinetic study of intravenous NAD+, a 6-hour infusion in 11 healthy adults
- **2020** • Remie et al [remie2020]. (American Journal of Clinical Nutrition), NR 1000 mg/day for 6 weeks shifts body composition in adults with obesity but does not improve insulin sensitivity

2020 • Dollerup et al [dollerup2020]. (Journal of Physiology), NR 1000 mg/day for 12 weeks does not alter mitochondrial respiration in skeletal muscle of obese insulin-resistant men

2020 • Mehmel et al [mehmel2020]. (Nutrients) review the state of nicotinamide riboside research and proposed therapeutic uses

2020 • Irie et al [irie2020]. (Endocrine Journal), first published single-dose human safety study of oral NMN (100, 500 mg) in Japanese men

2020 • Pirinen et al. (Cell Metabolism), niacin titrated to 750, 1000 mg/day for 10, 16 months restores systemic NAD+ and improves muscle performance in adult-onset mitochondrial myopathy [pirinen2020]. First positive functional-endpoint NAD+-repletion trial in humans

2021 • Liao et al [liao2021]. (J Int Soc Sports Nutr), NMN 300, 1200 mg/day for 6 weeks dose-dependently improves aerobic capacity in amateur runners

2021 • Yoshino M et al [yoshino2021]. (Science), NMN 250 mg/day for 10 weeks improves muscle insulin sensitivity in prediabetic postmenopausal women, the first positive metabolic-endpoint trial of an NAD+ precursor in humans

2021 • Covarrubias et al [covarrubias2021]. (Nature Reviews Molecular Cell Biology) review NAD+ metabolism and its roles in cellular processes during aging

2022 • Brakedal et al [brakedal2022]. (Cell Metabolism), NADPARK randomized phase I trial of NR in Parkinson disease shows brain NAD+ rise on 31P-MRS

2022 • Igarashi et al [igarashi2022]. (npj Aging), chronic NMN 250 mg/day for 12 weeks raises blood NAD+ and modestly improves muscle function in healthy older men

2022 • Jensen et al [jensen2022]. (JCI Insight), NR plus pterostilbene does not accelerate muscle injury recovery in elderly individuals despite NAD+ metabolome rise

2023 • Pencina et al [pencina2023]. (J Gerontol A), MIB-626 (microcrystalline NMN polymorph) raises circulating NAD+ and metabolome in middle-aged and older adults

2023 • Berven et al [berven2023]. (Nature Communications), NR-SAFE trial: high-dose NR 3000 mg/day is safe and well-tolerated in Parkinson disease for 4 weeks

2024 • Yamaguchi et al [yamaguchi2024]. (Endocrine Journal), 12-week NMN 250 mg/day safety and metabolic effects in middle-aged Japanese men

2024 • Peclat et al [peclat2024]. (Cardiovasc Res), ecto-CD38-NADase inhibition protects mice from doxorubicin-induced cardiotoxicity, extending the CD38-targeting strategy to drug-induced cardiac injury

Clinical Contexts for NAD+ / NMN

Age-related NAD+ decline (research framework) EMERGING

Background biology, not an FDA-approved indication.

Human tissue NAD+ declines with age across skin, brain, liver, skeletal muscle, and adipose [massudi2012]. The decline is driven in part by CD38 upregulation [camacho_pereira2016] and is the rationale for NAD+ precursor and parenteral NAD+ supplementation strategies. No regulatory endpoint exists for 'restoring NAD+'; this is a research framework, not a treatment indication [imai2014; covarrubias2021].

Oral NR supplementation for raising blood NAD+ in healthy and metabolic-disease adults EMERGING

Pharmacokinetic and biomarker endpoint; clinical endpoint effects mixed.

Trammell (2016) [trammell2016], Airhart (2017) [airhart2017], Martens (2018) [martens2018], and Conze (2019) [conze2019] consistently show that oral NR raises blood/PBMC NAD+ in dose-dependent fashion with no significant safety signal across short- to medium-term dosing. Remie (2020) [remie2020] and Dollerup (2020) [dollerup2020] tested NR in metabolic-disease cohorts and found null effects on insulin sensitivity and mitochondrial respiration despite biomarker rises. NIAGEN holds GRAS status as a dietary supplement, not drug status [fda_gras_niagen].

Oral NMN supplementation for raising NAD+ and metabolic endpoints EMERGING

Emerging, small RCTs with one positive metabolic endpoint.

Yoshino M et al. (Science 2021) [yoshino2021] randomized 25 prediabetic postmenopausal women to NMN 250 mg/day for 10 weeks and showed improved muscle insulin sensitivity on hyperinsulinemic-euglycemic clamp, the first positive metabolic endpoint in a human NMN trial. Igarashi (2022) [igarashi2022] showed NMN raised blood NAD+ and improved gait/grip in older men. Pencina (2023) [pencina2023] characterized the MIB-626 polymorph. NMN is not GRAS in the United States; FDA has declined to permit NMN sale as a dietary supplement.

NR in early Parkinson disease EMERGING

Phase I trial endpoints; not an FDA-approved indication.

The NADPARK trial [brakedal2022] [brakedal2022] randomized 30 adults with newly diagnosed Parkinson disease to NR 1000 mg/day or placebo for 30 days. Brain NAD+ on 31P-MRS rose in NR-treated patients; cerebrospinal fluid and plasma NAD-metabolome shifts were consistent. Clinical endpoints in this short trial were exploratory; a longer-duration efficacy trial (NR-SAFE / NO-PARK) is ongoing.

IV NAD+ infusion (compounded) EMERGING

Tier-3 emerging. Published peer-reviewed human evidence is essentially one pharmacokinetic pilot plus case-series; broader clinical use is anecdotal and unstandardized.

Grant et al. (2019) [grant2019] is the principal peer-reviewed human PK study: an open-label 6-hour infusion of 750 mg NAD+ in 11 healthy adults, with serial plasma and urine sampling. Plasma NAD+ rose with delayed kinetics consistent with extensive extracellular metabolism to nicotinamide and salvage-pathway metabolites. No controlled clinical-endpoint trial of IV NAD+ in addiction medicine, post-acute recovery, or general wellness has been published. RonanRx position: legitimate when a patient and physician have a specific protocol context; not a DTC longevity product.

Adult-onset mitochondrial myopathy (niacin, not NR/NMN) EMERGING

The strongest positive functional-endpoint NAD+-repletion result in humans is from niacin in a rare disease cohort, not an FDA-approved indication.

Pirinen et al. (2020, Cell Metabolism) [pirinen2020] gave niacin titrated to 750, 1000 mg/day for 10, 16 months in 10 adults with adult-onset mitochondrial myopathy and progressive external ophthalmoplegia. Systemic NAD+ was restored to control levels, muscle strength and mitochondrial biogenesis increased, and the trial provides the principal human precedent that NAD+-axis repletion can translate to a functional clinical endpoint, using nicotinic acid rather than NR or NMN.

Heart failure and cardiac aging (preclinical) PRECLINICAL

Preclinical. No randomized human cardiac endpoint trial of NR, NMN, or IV NAD+ has reported.

Diguet et al. (2018, Circulation) [diguet2018] showed oral NR preserves cardiac function, restores myocardial NAD+, and improves survival in a mouse model of dilated cardiomyopathy. Peclat et al. (2024, Cardiovasc Res) [peclat2024] extended CD38 inhibition cardioprotection to doxorubicin-induced cardiotoxicity. The Chini lab CD38/NAD pharmacology literature [chini2018, tarrago2018] frames the mechanistic case. Human translation has not yet reported.

Skin-cancer chemoprevention (oral nicotinamide) WELL STUDIED

Tier 1, 2 evidence for oral nicotinamide in high-risk patients, distinct from NR/NMN/IV NAD+ but the strongest randomized endpoint trial in the vitamin-B3 family.

The ONTRAC trial [chen2015_ontrac] [chen2015_ontrac] randomized 386 high-risk patients to oral nicotinamide 500 mg twice daily and showed a 23% reduction in new nonmelanoma skin cancers at 12 months. Surjana et al. (2012) [surjana2012] showed a 29, 35% reduction in actinic keratoses on the same regimen. The dermatology literature is summarized in Snaidr 2019 [snaidr2019]. This is oral nicotinamide chemoprevention, not an NAD+ precursor mechanism in the NR/NMN sense, but the strongest randomized endpoint trial of any B3-family compound and the principal long-term-exposure safety dataset.

Type 1 diabetes prevention (nicotinamide; negative) WELL STUDIED

Negative endpoint trial, included for honesty about the historical vitamin-B3 evidence base.

The ENDIT trial [gale2004_endit] [gale2004_endit] randomized 552 islet-autoantibody-positive first-degree relatives at risk for type 1 diabetes to oral nicotinamide vs placebo for a median 5 years. Nicotinamide did not prevent or delay onset of type 1 diabetes. The trial nonetheless established long-term high-dose nicotinamide tolerability in adolescents and adults, which bounds the chronic-exposure safety envelope for the broader B3 family.

Off-Label Uses of NAD+ / NMN

General wellness / longevity (IV NAD+ drip culture) EMERGING

Not supported by published controlled trials; RonanRx does not dispense for DTC wellness use.

Public marketing of IV NAD+ for 'longevity', 'energy', or generalized wellness is not supported by published controlled human trials. The single PK pilot [grant2019] establishes that infused NAD+ enters the systemic circulation and is metabolized, but does not demonstrate clinical benefit. RonanRx 503A does not compound IV NAD+ for DTC wellness drip protocols; dispensing requires a documented patient-specific clinical indication and physician-directed protocol.

Compounded NAD+ / NMN (503A)

RonanRx dispenses compounded NAD+, typically as sterile injectable solutions for IV infusion, IM, or SC administration, under 503A on patient-specific prescriptions only. Oral NR and NMN are dietary supplements outside the compounding pathway; the 503A scope at RonanRx covers parenteral NAD+ preparations and, where prescribed, parenteral nicotinamide [fda503a] [trammell2016; martens2018].

The clinical evidence framing is important: the only peer-reviewed human PK study of IV NAD+ is Grant et al [fda503a]. (2019) [grant2019]. Beyond that, the published literature on IV NAD+ for clinical conditions is anecdotal, case series, observational reports, and unpublished clinic protocols. This is a true Tier-3 emerging-evidence compound. RonanRx compounds IV/IM/SC NAD+ when a patient and physician have a specific protocol context (for example, addiction-medicine-adjacent protocols, post-acute recovery contexts, or other clinician-supervised use cases) and when the prescriber documents the clinical rationale [conze2019]. RonanRx does not market or dispense compounded NAD+ as a DTC longevity product [yoshino2021].

Because the precursors NR and NMN are dietary supplements with substantial published PK and safety literature, a prescriber considering NAD+-axis therapy may reasonably evaluate oral precursors as a first-line option before parenteral NAD+ [fda503a] [pencina2023]. The pharmacist review process documents this consideration.

NAD+ / NMN Formulations and Routes

Form	Concentration	Description
Sterile NAD+ injection (compounded, IV/IM/SC)	Custom; commonly 100 mg/mL for IV infusion preparations, with single-dose volumes calibrated to a 250, 1000 mg/dose protocol depending on indication and clinician direction	Sterile aqueous solution of NAD+ disodium prepared under USP <797> standards for sterile compounding on a patient-specific prescription. Container closure, excipient profile, and concentration are documented per batch and matched to the prescriber's protocol.
Oral NR (nicotinamide riboside chloride)	Typically 100, 300 mg per capsule; supplement-grade NIAGEN product	Oral NR is a GRAS dietary supplement (NIAGEN, ChromaDex) outside the 503A pathway. Included here for completeness of the NAD+ axis; not compounded by RonanRx.
Oral NMN	Typically 125, 300 mg per capsule	Oral NMN is sold as a supplement in some jurisdictions; FDA has declined to permit NMN sale as a dietary supplement in the United States after its prior investigation as a pharmaceutical. Included here for completeness; not compounded by RonanRx.

Routes used in published literature: intravenous, intramuscular, subcutaneous, oral.

NAD+ / NMN Dosing

Route	Population	Range	Duration	Study type
Intravenous	Adults receiving clinician-directed IV NAD+ infusion under a specific protocol	250, 1000 mg per infusion in 250, 500 mL diluent infused over 2, 6 hours; clinician-directed scheduling. Grant et al. (2019) used a single 750 mg dose infused over 6 hours in healthy adults.	Per clinician protocol; not standardized in controlled trials	Open-label pharmacokinetic pilot plus uncontrolled case-series
Subcutaneous or intramuscular	Adults under clinician-directed compounded	50, 200 mg per injection; clinician-directed scheduling	Per clinician protocol	Anecdotal / case-series only; no controlled human trials

Route	Population	Range	Duration	Study type
	NAD+ injection protocol			
Oral (NR, supplement, included for reference)	Adults	300, 1000 mg/day across published RCTs	6, 12 weeks in published trials	Multiple randomized controlled trials
Oral (NMN, supplement, included for reference)	Adults	250 mg/day in the principal published RCTs; up to 1000, 2000 mg/day in MIB-626 dose-ranging	10, 12 weeks in published trials	Small randomized controlled trials

There is no FDA-approved labeled dose for NAD+, NR, or NMN. IV NAD+ dosing in clinic protocols varies widely (typically 250, 1000 mg per infusion over 2, 6 hours, sometimes repeated daily over 5, 10 days for an addiction-medicine-style course) and is not standardized in controlled trials. The only published peer-reviewed human PK protocol is Grant et al. (2019): a single 750 mg infusion over 6 hours in 11 healthy adults [grant2019].

RonanRx does not promote or dispense a specific IV NAD+ protocol. Compounded NAD+ is prepared to the prescriber's order at the concentration and total dose specified, and pharmacist review confirms that a clinical rationale and protocol are documented. Prescribers considering parenteral NAD+ should be aware that the published evidence base is essentially one PK pilot plus uncontrolled case-series, the evidence is qualitatively different from the oral NR/NMN trial literature.

NAD+ / NMN Safety

Oral NR has been well-tolerated in published trials. Dollerup et al. (2018, AJCN) [42] reported no serious adverse events in obese, insulin-resistant men on NR 1000 mg twice daily for 12 weeks. Conze et al. (2019) [14] reported no serious adverse events on NR up to 600 mg/day for 8 weeks; Martens et al. (2018) [13] reported clean tolerability at 1000 mg/day for 6 weeks; Remie et al. (2020) [16] and Dollerup et al. (2020) [17] reported tolerable profiles at 1000 mg/day for 6, 12 weeks; Elhassan et al. (2019) [43] reported tolerability with reductions in inflammatory markers in aged adults. Mild gastrointestinal symptoms (nausea, flushing, headache) have been reported sporadically. NIAGEN holds GRAS status [25]. Oral nicotinamide has been administered at 1.2 g/day for a median 5 years in the ENDIT type 1 diabetes prevention trial [35] and 1 g/day for 12 months in the ONTRAC skin-cancer chemoprevention trial [36] without serious safety signals, bounding the long-term-exposure envelope for the B3 family [20].

Oral NMN trials reported tolerability without serious adverse events. Irie et al. (2020) [45] noted modest rises in serum bilirubin and creatinine after single NMN doses up to 500 mg, motivating downstream

surveillance of these markers, but the changes were not clinically significant. Trial durations remain short (4, 12 weeks) and sample sizes small (10, 48 participants), which limits adverse-event characterization. Yamaguchi 2024 [50] extends NMN safety to 12 weeks at 250 mg/day in middle-aged men.

A theoretical concern specific to NR pharmacology is the methyl-group sink. Trammell et al. (2016) [9] showed that oral NR is extensively methylated to N-methylnicotinamide and excreted; chronic high-dose precursor loading could in principle compete with other methylation pathways (homocysteine remethylation, neurotransmitter synthesis). No clinical harm has been documented in published trials at typical doses, but this is the most-discussed theoretical signal for high-dose chronic NR or nicotinamide [22].

IV NAD+ safety data are sparse. Grant et al. (2019) [15] reported the infusion was 'tolerable' in 11 healthy adults but participants reported pressure or chest tightness during rapid infusion phases, a finding consistent with widely reported clinic experience that IV NAD+ must be infused slowly to avoid discomfort. No controlled long-term safety study of IV NAD+ exists. The high-dose NR-SAFE Parkinson trial [49] establishes safety of NR at 3000 mg/day for 4 weeks but does not translate to the parenteral route. Theoretical concerns relevant to the NAD+ axis include potential interactions with chemotherapy (PARP-dependent DNA-damage signaling), potential nicotinamide accumulation with high or repeated dosing, and unknown effects of chronically elevated NAD+ on CD38- and sirtuin-mediated immunometabolism [41]; none of these are documented as clinical harms in the published literature, but the absence of large controlled trials means absence of evidence is not evidence of safety [4723].

RonanRx framing: compounded IV/IM/SC NAD+ is a Tier-3 emerging-evidence preparation. The safety profile of oral NR and NMN is reasonably well-characterized for the dose ranges and durations studied [23]. The safety profile of IV NAD+ in routine clinical use is not well-characterized and must be considered in the prescriber's risk-benefit assessment.

Contraindications

There is no FDA-labeled contraindication list for NAD+, NR, or NMN because no FDA-approved drug product exists in these forms. Prescriber discretion applies. Reasonable cautions include: active malignancy receiving PARP-targeted or DNA-damaging chemotherapy (theoretical interaction via NAD+-dependent DNA-damage response); known hypersensitivity to the active ingredient or compounded preparation excipients; pregnancy and lactation (no published controlled human data); and severe hepatic or renal impairment (no dedicated PK studies of parenteral NAD+ in these populations).

Niacin (nicotinic acid) has its own labeled contraindications (active liver disease, active peptic ulcer, arterial bleeding) under the Niaspan label [24]; these are specific to niacin and do not necessarily transfer to NR, NMN, or NAD+.

Drug interactions

Drug-interaction data for NAD+, NR, and NMN are limited. Theoretical interactions to consider: (1) chemotherapy agents that engage PARP-mediated DNA damage signaling (PARP is an NAD+-consuming

enzyme); (2) immunosuppressants and other agents that modulate CD38 or sirtuin pathways; (3) other vitamin-B3 forms (niacin, nicotinamide) where additive nicotinamide load could matter at high doses; and (4) agents with overlapping vascular or flushing effects (niacin in particular is associated with prostaglandin-mediated flushing, distinct from NR/NMN) [24].

No clinically significant CYP-mediated drug-drug interactions have been characterized for NR, NMN, or parenteral NAD+ in published studies [19].

Adverse events

Oral NR: in the principal RCTs, the most commonly reported adverse events are mild gastrointestinal symptoms (nausea, dyspepsia), headache, and occasional flushing. Adverse-event-driven discontinuation rates have been low and comparable to placebo. No serious adverse events attributable to NR have been reported in trials up to 12 weeks at doses up to 1000 mg/day [17].

Oral NMN: in the published trials [20][22][23], tolerability has been reported as good with no serious adverse events. Trial durations have been short (10, 12 weeks) and sample sizes small (25, 80 participants), which limits adverse-event characterization.

IV NAD+: Grant et al. (2019) [15] reported infusion-related transient discomfort (pressure sensation, mild chest tightness) particularly during rapid infusion phases, mitigated by slowing the infusion rate. Headache, nausea, and flushing during infusion are commonly described in clinic experience. The published evidence base does not characterize a controlled adverse-event profile for repeated or chronic IV NAD+ use [13][14][16].

Monitoring NAD+ / NMN Therapy

There is no standard monitoring protocol for NAD+ supplementation or infusion. Reasonable baseline assessment depends on the indication and route: a clinical history including current medications and any prior NAD+-axis supplementation; for parenteral protocols, a focused review of the protocol's stated indication and duration; and patient education on infusion-related side effects (pressure, flushing, nausea).

Blood NAD+ levels can be measured but are not standardized clinically and the interpretation in routine practice is unclear. Routine laboratory monitoring (CBC, comprehensive metabolic panel) is appropriate per clinician judgment but is not required by any regulatory standard for compounded NAD+.

NAD+ / NMN in Special Populations

NAD+ / NMN Evidence Quality

The NAD+ axis is one of the most active areas of aging biology, with strong mechanistic and preclinical underpinning but a mixed human translation. The mechanistic case, that tissue NAD+ declines with age [massudi2012], that CD38 drives much of the decline [camacho_pereira2016, chini2018, tarrago2018], that sirtuins are NAD+-dependent and metabolically important, that the NAD+/sirtuin axis modulates lifespan via the mitochondrial UPR [mouchiroud2013], that NR rescues high-fat-diet metabolic dysfunction in mice [canto2012], that long-term NMN mitigates age-associated decline across organ systems in mice [mills2016], and that NR preserves cardiac function in mouse models of dilated cardiomyopathy [diguet2018], is consistent and well-supported.

Human evidence for oral NAD+ precursors is at the small-RCT scale and totals roughly a dozen randomized trials between NR and NMN as of 2026 [conze2019]. Oral NR reliably raises blood/PBMC NAD+ in dose-dependent fashion across multiple trials and Elhassan 2019 confirmed intramuscular NAD+ metabolome elevation on muscle biopsy in aged humans [elhassan2019] [irie2020; pencina2023]. Effects on clinical endpoints have been mixed: NADPARK [brakedal2022] showed brain NAD+ rise in Parkinson disease and the follow-on NR-SAFE [berven2023] confirmed high-dose tolerability, but firm clinical efficacy awaits the NO-PARK trial [imai2014]. Metabolic-disease cohorts on NR [dollerup2018, remie2020, dollerup2020] showed null effects on insulin sensitivity and mitochondrial respiration despite NAD+ rises. The NR+pterostilbene muscle-injury trial [jensen2022] was also null [covarrubias2021; martens2018]. The strongest positive functional-endpoint NAD+-repletion result in humans is not from NR or NMN but from niacin restoring systemic NAD+ levels and improving muscle performance in adult-onset mitochondrial myopathy [pirinen2020] [imai_guarente2010; bonkowski2016].

Oral NMN trials are smaller still, with positive endpoints in muscle insulin sensitivity [yoshino2021], aerobic capacity [liao2021], and muscle function [igarashi2022], and consistent biomarker confirmation of blood NAD+ rise across the cohort. Tolerability is good through 12 weeks and 250 mg/day; longer-duration and higher-dose data are limited. The vitamin-B3 family safety case at chronic high doses is anchored by the multi-year ENDIT trial of nicotinamide 1.2 g/day in adolescents and adults [gale2004_endit] and the ONTRAC trial of nicotinamide 1 g/day for 12 months [chen2015_ontrac, surjana2012, snaidr2019], these are not NAD+-precursor trials in the modern sense but they bound the chronic-exposure safety envelope for the broader vitamin family.

Human evidence specifically for IV NAD+ in clinical use is essentially anecdotal/case-series. The Grant 2019 pilot [grant2019] is the principal peer-reviewed human PK reference. No controlled clinical-endpoint trial of IV NAD+ in addiction medicine, post-acute recovery, neurodegenerative disease, or general wellness

has been published. The mechanistic biology, that infused NAD+ is largely metabolized extracellularly to nicotinamide and downstream precursors before tissue uptake [grant2019], suggests that any benefit of IV NAD+ over equivalent oral precursor exposure has yet to be demonstrated in controlled human trials [trammell2016; airhart2017]. RonanRx therefore classifies parenteral NAD+ as Tier-3 emerging evidence and dispenses on patient-specific prescription with documented clinician rationale only [yamaguchi2024]. The growing CD38-inhibitor literature [tarrago2018, peclat2024, chini2018] is a distinct pharmacologic strategy not yet in human clinical trials.

Major NAD+ / NMN Clinical Studies

Study	Design	Participants	Duration	Finding
Trammell et al. (2016, Nature Communications), first human PK of oral NR	Mouse PK plus single-ascending-dose human study of nicotinamide riboside	—	Acute (single oral dose escalation)	Oral NR is uniquely orally bioavailable; dose-dependent elevation of blood NAD+ metabolome in humans [trammell2016]. Established NR as a tractable oral NAD+ precursor distinct from niacin and nicotinamide.
Martens et al. (2018, Nature Communications), chronic NR in healthy older adults	Randomized, double-blind, placebo-controlled crossover trial of NR 1000 mg/day in healthy middle-aged and older adults	30	6 weeks per arm	NR roughly doubled PBMC NAD+ and reduced systolic blood pressure modestly; tolerability comparable to placebo [martens2018].
Conze et al. (2019, Scientific Reports), long-term NR tolerability	Randomized, double-blind, placebo-controlled trial of NR (NIAGEN) 100, 300, and 600 mg/day in adults with overweight	140	8 weeks	Dose-dependent elevation of whole-blood NAD+; no significant adverse-event signal vs placebo. Anchors GRAS safety case for NR [conze2019].
Remie et al. (2020, AJCN), NR in adults with obesity	Randomized, double-blind, placebo-controlled crossover trial of NR 1000 mg/day in adults with obesity	13	6 weeks per arm	NR raised NAD+ metabolome and shifted body composition (reduced acetylcarnitines) but did not improve insulin sensitivity, mitochondrial function, or substrate metabolism [remie2020].

Study	Design	Participants	Duration	Finding
Dollerup et al. (2020, J Physiol), NR in obese insulin-resistant men	Randomized, double-blind, placebo-controlled parallel-group trial of NR 1000 mg/day in obese insulin-resistant men	40	12 weeks	NR did not alter mitochondrial respiration, content, or morphology in skeletal muscle; further evidence that NAD+ blood rise does not consistently translate to tissue-level functional change [dollerup2020].
Yoshino M et al. (2021, Science), NMN in prediabetic women	Randomized, double-blind, placebo-controlled trial of NMN 250 mg/day in prediabetic postmenopausal women	25	10 weeks	NMN improved muscle insulin sensitivity on hyperinsulinemic-euglycemic clamp, first positive human metabolic-endpoint trial of an NAD+ precursor [yoshino2021].
Igarashi et al. (2022, npj Aging), NMN in older men	Randomized, double-blind, placebo-controlled trial of NMN 250 mg/day in healthy older men	42	12 weeks	Blood NAD+ elevation with modest improvements in muscle function (gait speed, grip strength) [igarashi2022].
Pencina et al. (2023, J Gerontol A), MIB-626 NMN polymorph	Randomized, double-blind, placebo-controlled dose-ranging trial of MIB-626 (microcrystalline NMN) 1000, 2000 mg/day in middle-aged and older adults	—	14 days	Dose-dependent elevation of whole-blood and PBMC NAD+ and shifts in the NAD+ metabolome [pencina2023].
Brakedal et al. (2022, Cell Metabolism), NADPARK	Randomized phase I trial of NR 1000 mg/day in adults with newly diagnosed Parkinson disease	30	30 days	Brain NAD+ rise on 31P-MRS; consistent CSF and plasma metabolome shifts; established the disease-model NAD+ rise rationale that motivates longer-duration trials [brakedal2022].
Grant et al. (2019, Front Aging	Open-label pilot pharmacokinetic study of a single 750 mg NAD+ intravenous	11	Single 6-hour infusion with serial	Plasma NAD+ rose with delayed kinetics; metabolite signature in plasma and urine consistent with extensive extracellular

Study	Design	Participants	Duration	Finding
Neurosci), IV NAD+ pilot PK	infusion over 6 hours in healthy adults		plasma and urine sampling	metabolism [grant2019]. Tolerable when infused slowly. This is the principal peer-reviewed human PK reference for IV NAD+ in the compounded-pharmacy literature.
Massudi et al. (2012, PLoS ONE), Age-related NAD+ decline in human tissue	Cross-sectional measurement of NAD+, NADH, NAD/NADH ratio, and PARP activity in human skin samples across the adult lifespan	—	—	Documented decline in NAD+ with age and rising oxidative-stress markers, a key human reference for the aging-decline framework [massudi2012].
Camacho-Pereira et al. (2016, Cell Metabolism), CD38 mechanism	Preclinical mechanistic study of CD38 in age-related NAD+ decline using CD38-knockout mice and tissue biochemistry	—	—	CD38 upregulation drives age-related NAD+ decline via a SIRT3-dependent mitochondrial dysfunction mechanism; CD38 knockout protects against the decline [camacho_pereira2016].
Mills et al. (2016, Cell Metabolism), Long-term NMN in mice	12-month oral NMN administration study across multiple organ systems in C57BL/6 mice	—	—	NMN mitigated age-associated physiological decline in energy metabolism, insulin sensitivity, eye function, bone density, and gene-expression profiles; preclinical foundation for human NMN trials [mills2016].
Yoshino et al. (2011, Cell Metabolism), NMN in diet/age-induced diabetic mice	Preclinical NMN intervention in diet- and age-induced diabetes mouse models	—	—	Intraperitoneal NMN treated impaired glucose tolerance and lipid abnormalities; preclinical rationale for human NMN trials [yoshino2011].
Airhart et al. (2017, PLoS ONE), Open-label NR PK	Open-label, non-randomized PK study of oral NR in healthy adults	8	8 days	Confirmed dose-related blood NAD+ rise on oral NR dosing; supported the chronic-dosing trials that followed [airhart2017].
		40	12 weeks	

Study	Design	Participants	Duration	Finding
Dollerup et al. (2018, Am J Clin Nutr), NR safety and insulin sensitivity in obese men	Randomized, double-blind, placebo-controlled parallel-group trial of NR 1000 mg twice daily in obese, insulin-resistant men			NR was well-tolerated with no serious adverse events. No improvement in insulin sensitivity (hyperinsulinemic-euglycemic clamp), endogenous glucose production, lipolysis, or substrate oxidation despite elevated NAD+ metabolome. Provided the primary safety dataset alongside Conze 2019 [dollerup2018].
Elhassan et al. (2019, Cell Reports), NR in aged human skeletal muscle	Randomized, double-blind, placebo-controlled crossover trial of NR 1000 mg/day in aged men with muscle biopsy	12	21 days per arm	NR augmented the skeletal muscle NAD+ metabolome and induced transcriptomic anti-inflammatory signatures; circulating IL-6 and other inflammatory markers fell [elhassan2019]. First trial demonstrating intramuscular NAD+ metabolome elevation on oral NR in aged humans.
Jensen et al. (2022, JCI Insight), NR+pterostilbene in muscle injury	Randomized, double-blind, placebo-controlled trial of NR plus pterostilbene in elderly participants undergoing experimental muscle injury and recovery	32	Pre/post injury protocol	Combined NR+pterostilbene did not accelerate muscle regeneration or improve recovery markers vs placebo despite NAD+ metabolome rise [jensen2022]. Adds to the body of null-functional-endpoint NR trials.
Liao et al. (2021, J Int Soc Sports Nutr), NMN in amateur runners	Randomized, double-blind, placebo-controlled, dose-ranging trial of NMN 300, 600, or 1200 mg/day in amateur male runners under exercise training	48	6 weeks	Dose-dependent improvement in aerobic capacity (VO2max-derived ventilatory thresholds) in the NMN groups vs placebo [liao2021]. One of the first non-Japanese, non-Western academic NMN trials with a functional endpoint.
Irie et al. (2020, Endocrine Journal), Single-dose NMN	Single-blind, single-ascending-dose trial of NMN 100, 250, and	10	Single dose with 5-hour	NMN was well-tolerated up to 500 mg; no clinically significant changes in vital signs,

Study	Design	Participants	Duration	Finding
safety in Japanese men	500 mg oral in healthy Japanese men		PK sampling	ophthalmologic, or laboratory parameters. Serum bilirubin and creatinine rose modestly, motivating downstream safety surveillance. First published human safety report on oral NMN [irie2020].
Yamaguchi et al. (2024, Endocrine Journal), Long-term NMN safety in middle-aged Japanese men	Randomized, double-blind, placebo-controlled trial of NMN 250 mg/day in middle-aged Japanese men	30	12 weeks	NMN raised blood NAD+ and was well-tolerated with no serious adverse events; sleep quality and modest metabolic markers shifted favorably. Extends the Igarashi NMN safety profile to a longer follow-up [yamaguchi2024].
Diguet et al. (2018, Circulation), NR in dilated cardiomyopathy mouse model	Preclinical NR feeding study in a serum response factor (SRF) knockout mouse model of dilated cardiomyopathy	—	—	NR supplementation preserved cardiac function, restored myocardial NAD+, and improved survival vs untreated mutants [diguet2018]. Provides the principal preclinical rationale for NAD+ precursor trials in heart failure.
Tarragó et al. (2018, Cell Metabolism), CD38 inhibitor 78c reverses age-related NAD+ decline	Preclinical pharmacology of the small-molecule CD38 inhibitor 78c in aged mice	—	—	78c reversed age-related tissue NAD+ decline, improved glucose tolerance, muscle function, and exercise capacity in aged mice [tarrago2018]. Established CD38 inhibition as an alternative pharmacologic strategy to precursor loading for restoring NAD+.
Peclat et al. (2024, Cardiovasc Res), CD38 inhibition in doxorubicin cardiotoxicity	Preclinical ecto-CD38 inhibition in a mouse model of doxorubicin-induced cardiotoxicity	—	—	Ecto-CD38 inhibition modulated cardiac NAD+ metabolism and protected against doxorubicin cardiotoxicity [peclat2024]. Extends the CD38-targeting hypothesis from aging to drug-induced cardiac injury.

Study	Design	Participants	Duration	Finding
Pirinen et al. (2020, Cell Metabolism), Niacin in mitochondrial myopathy	Open-label phase II trial of niacin (nicotinic acid) titrated to 750, 1000 mg/day in adult-onset mitochondrial myopathy with progressive external ophthalmoplegia	10	10, 16 months	Niacin restored systemic NAD+ to control levels and increased muscle strength and mitochondrial biogenesis in patients [pirinen2020]. The first human NAD+-repletion trial in a primary mitochondrial disease with a positive functional endpoint.
Cantó et al. (2012, Cell Metabolism), NR protects against diet-induced obesity in mice	Preclinical study of oral NR in high-fat-diet-fed C57BL/6 mice	—	—	NR enhanced oxidative metabolism in muscle and brown adipose, activated SIRT1 and SIRT3, and protected against high-fat-diet obesity and insulin resistance [canto2012]. Key preclinical foundation for human NR metabolic trials.
Mouchiroud et al. (2013, Cell), NAD+/ sirtuin axis and longevity via UPR-mt and FOXO	Mechanistic study in C. elegans and mammalian cells of NAD+ repletion and PARP inhibition	—	—	NAD+ repletion activated the mitochondrial unfolded protein response (UPR-mt) and FOXO signaling in a SIR-2.1-dependent manner; extended lifespan in worms [mouchiroud2013]. Established the UPR-mt as a downstream effector of NAD+/ sirtuin signaling in aging.
Bieganowski & Brenner (2004, Cell), Discovery of NR as an NAD+ precursor	Yeast genetics and biochemistry identifying nicotinamide riboside kinase (NRK) genes	—	—	Identified NR as a third NAD+ precursor vitamin distinct from niacin and nicotinamide, establishing the Preiss, Handler-independent NRK salvage route conserved from fungi to humans [bieganowski2004]. Foundational paper for the entire NR therapeutic field.
Belenky et al. (2007, Cell), NR extends lifespan via Sir2 in yeast	Yeast genetic study of NR salvage pathways and Sir2-dependent lifespan	—	—	Exogenous NR extended replicative lifespan in S. cerevisiae via Nrk1 and Urh1/ Pnp1/Meu1 pathways feeding

Study	Design	Participants	Duration	Finding
				NAD+ for Sir2-mediated silencing [belenky2007_cell]. Mechanistic link from NR salvage to sirtuin-dependent longevity.
Berven et al. (2023, Nature Communications), NR-SAFE high-dose NR in Parkinson disease	Randomized, double-blind, placebo-controlled safety trial of high-dose NR 3000 mg/day in Parkinson disease	20	4 weeks	High-dose NR was safe and well-tolerated in PD patients with no serious adverse events. Brain NAD+ rose on 31P-MRS; tolerability comparable to placebo. Extends NADPARK safety envelope to a higher dose [berven2023].
Chen et al. (2015, NEJM), ONTRAC oral nicotinamide for skin-cancer chemoprevention	Randomized, double-blind, placebo-controlled trial of oral nicotinamide 500 mg twice daily in high-risk patients with prior nonmelanoma skin cancers	386	12 months	Nicotinamide reduced new nonmelanoma skin cancers by 23% vs placebo. Largest positive randomized endpoint trial of any vitamin-B3 family compound and the strongest precedent for chronic oral nicotinamide safety in adults [chen2015_ontrac].
Gale et al. (2004, Lancet), ENDIT nicotinamide for type 1 diabetes prevention	European Nicotinamide Diabetes Intervention Trial, randomized, double-blind, placebo-controlled trial of nicotinamide in islet-autoantibody-positive first-degree relatives at risk for type 1 diabetes	552	Median 5 years	Nicotinamide did not prevent or delay onset of type 1 diabetes [gale2004_endit]. Negative for the primary endpoint, but established long-term high-dose nicotinamide safety in adults and adolescents.
Surjana et al. (2012, J Invest Dermatol), Oral nicotinamide for actinic keratoses	Two phase II randomized, double-blind, placebo-controlled trials of oral nicotinamide 500 mg once or twice daily	76	4 months	Nicotinamide reduced actinic keratosis counts by 29, 35% vs placebo [surjana2012]. Established the dermatologic precedent that became ONTRAC.

Study	Design	Participants	Duration	Finding
	in patients with actinic keratoses			

NAD+ / NMN Pharmacokinetics & Pharmacodynamics

Pharmacokinetics

Oral nicotinamide riboside is absorbed in the small intestine and undergoes extensive first-pass hepatic conversion. Trammell et al. (2016) [trammell2016] characterized the human PK: single-dose blood NAD+ metabolome rises in a dose-dependent way at 100, 300, and 1000 mg, with the rise persisting for hours. Chronic dosing studies [martens2018, conze2019] show steady-state elevation of PBMC NAD+ that returns to baseline after discontinuation. Oral NMN PK in humans is less fully characterized but similarly shows dose-dependent blood NAD+ rise [yoshino2021, igarashi2022, pencina2023].

Intravenous NAD+ PK was characterized by Grant et al. (2019) [grant2019] in a single open-label pilot. An infusion of 750 mg NAD+ over 6 hours in 11 healthy adults produced delayed plasma NAD+ rise (not paralleling the infusion rate), with concurrent rise in plasma and urinary metabolites (nicotinamide, methylnicotinamide, NAAD, ADPR). The delayed kinetics suggest extensive extracellular metabolism of infused NAD+ to nicotinamide and salvage-pathway intermediates, which may then be taken up and resalvaged intracellularly. No human study has characterized tissue-level NAD+ delivery after IV NAD+ infusion.

Pharmacodynamics

Pharmacodynamic endpoints studied in NAD+-axis trials include blood and PBMC NAD+ and NAD+-metabolome elevation (consistently demonstrated across NR and NMN trials), muscle insulin sensitivity (improved in Yoshino 2021 NMN trial, not improved in NR trials in metabolic disease), mitochondrial respiration in skeletal muscle (not improved in Dollerup 2020 NR trial), body composition and acetylcarnitine concentrations (modest shifts in Remie 2020 NR trial), and brain NAD+ on 31P-MRS (elevated in NADPARK NR trial in Parkinson disease) [remie2020; dollerup2020; yoshino2021].

The pattern is consistent: NAD+ rises in blood reliably; tissue-level functional consequences are variable and context-dependent. The pharmacodynamic case for IV NAD+ is least developed, no controlled functional-endpoint trial of IV NAD+ has been published [martens2018] [brakedal2022; grant2019].

NAD+ / NMN Storage and Handling

Compounded sterile NAD+ solutions are stored refrigerated (2, 8°C) and protected from light per the pharmacy's stability data and beyond-use date assignment under USP <797> [usp_797]. NAD+ is sensitive

to pH, oxidation, and light, so excipient buffering and container selection are documented per batch. Oral NR and NMN supplements are stored at room temperature per supplement label instructions.

NAD+ / NMN Compounding & Operations

503A compounding

Compounded NAD+ is prepared under 503A on patient-specific prescriptions in state-licensed compounding pharmacies [fda503a]. RonanRx prepares sterile injectable NAD+ preparations per USP General Chapter <797>, with documented active ingredient sourcing, gravimetric verification, sterility and endotoxin testing per the pharmacy's quality-management system, and full lot traceability [usp_797]. For nonsterile preparative steps the corresponding USP General Chapter <795> applies; the finished injectable product is governed by <797> [usp_795].

Beyond-use dating, ingredient identity verification, sterility assurance, and stability assessment follow USP <797> requirements. Each compounded batch is documented per state board of pharmacy retention rules with full traceability from API lot through dispensing.

Pharmacist review

Each prescription for compounded NAD+ undergoes pharmacist review prior to dispensing [fda503a]. The review confirms: a documented patient-specific clinical reason and clinician-directed protocol (not a DTC longevity request); concentration and dose appropriate for the prescribed route (IV, IM, SC); absence of contraindicating clinical conditions in the available history; and concurrent medication review for theoretical interactions (active chemotherapy, immunosuppression).

RonanRx does not fill prescriptions that present as routine DTC wellness or longevity drip protocols without a documented clinician indication. The Tier-3 emerging evidence base for IV NAD+ in clinical use [grant2019] makes the pharmacist review threshold particularly important [fda503a].

Quality and traceability

Active pharmaceutical ingredient (NAD+, typically as the disodium salt) is sourced from FDA-registered facilities with documented certificates of analysis including identity, potency, and limits on heavy metals and microbial contaminants. Each compounded batch is recorded with lot numbers traceable to API source, compounding date, beyond-use date, sterility and endotoxin test results, and dispensing pharmacist of record. Finished product lot records are retained per state board of pharmacy retention requirements.

Cold chain

Compounded sterile injectable NAD+ is a cold-chain product. Refrigerated transport is used between the compounding pharmacy and the patient or prescribing clinic, with temperature monitoring through the shipment. Patients and clinics are advised to refrigerate the product on arrival, to inspect for temperature

excursions, and to contact the pharmacy if cold-chain integrity is in question. NAD+ solutions are also light-sensitive; original packaging should be preserved until administration.

Frequently Asked Questions About NAD+ / NMN

Is NAD+ FDA-approved?

No. There is no FDA-approved NAD+, NR, or NMN drug product [fda503a]. Niacin (nicotinic acid) is FDA-approved as Niaspan for dyslipidemia, but that is the cholesterol indication of the B3 vitamin and not an 'NAD+ booster' indication [fda_niaspan_label]. NR (NIAGEN) is sold as a GRAS dietary supplement [fda_gras_niagen]. Compounded NAD+ injections are 503A patient-specific preparations, not FDA-approved drugs.

What does the human evidence actually show for oral NR and NMN?

Across multiple randomized trials, oral NR and NMN reliably raise blood and PBMC NAD+ levels in dose-dependent fashion [yoshino2021; igarashi2022; pencina2023]. Effects on clinical endpoints have been mixed: one positive metabolic endpoint (Yoshino 2021 NMN improved muscle insulin sensitivity in prediabetic postmenopausal women) and several null findings in metabolic disease cohorts on NR [remie2020, dollerup2020] [conze2019]. NR raised brain NAD+ in early Parkinson disease (NADPARK) [brakedal2022] [trammell2016; martens2018].

What's published on IV NAD+?

One peer-reviewed human pharmacokinetic pilot: Grant et al. (2019), a 6-hour infusion of 750 mg NAD+ in 11 healthy adults [grant2019]. Plasma NAD+ rose with delayed kinetics and the metabolite signature suggested extensive extracellular metabolism. Beyond that, the clinical literature on IV NAD+ is anecdotal case-series. No controlled clinical-endpoint trial of IV NAD+ has been published.

Does RonanRx sell IV NAD+ direct-to-consumer?

No. RonanRx compounds NAD+ under 503A only on a patient-specific prescription from a licensed clinician with a documented clinical reason and protocol. We do not market or dispense IV NAD+ as a DTC longevity or wellness drip product [fda503a].

Is NAD+ the same as niacin?

No. Niacin (nicotinic acid) is a B3 vitamin and a precursor that feeds into NAD+ biosynthesis through the Preiss, Handler pathway, but it is not NAD+ itself [bogan2008]. Niaspan (extended-release niacin) is the FDA-labeled product in dyslipidemia, not an NAD+-raising indication [fda_niaspan_label]. NR and NMN are different B3-family precursors that feed the salvage pathway. Compounded NAD+ is the intact dinucleotide [belenky2007].

Why does NAD+ decline with age?

Multiple mechanisms appear to contribute, but the best-characterized driver is increased activity of CD38, an NAD+-consuming glycohydrolase that rises with age and inflammation [camacho_pereira2016]. NAD+ is not 'running out' so much as being destroyed faster than it is replaced [bonkowski2016]. PARP activation from accumulated DNA damage and sirtuin consumption also contribute [massudi2012; covarrubias2021].

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How to Access NAD+ / NMN

Compounded NAD+ / NMN is dispensed under 503A on a patient-specific prescription. Depending on your role, the next step looks different.

FOR PRESCRIBING CLINICIANS

Offer this medication

A pharmacist will follow up within two business days. We'll cover state availability, supported formulations, and what integration looks like for your clinic.

ronanrx.com/request-partnership-call

PATIENT WITH A DOCTOR

Receive your prescription

If your doctor has prescribed NAD+ / NMN, sign up so we can prepare and ship your medication. The signup wizard collects intake and connects you to the prescribing workflow.

ronanrx.com/patients

PATIENT WITHOUT A DOCTOR

Find a partner clinic

RonanRx prescribes through partner clinics — we don't initiate prescriptions on this site. Read how the referral process works and how to find a partner clinic in your state.

ronanrx.com/find-clinic

Other compounds RonanRx makes

This monograph is one of many in the RonanRx formulary. Every compound below is prepared under 503A on a patient-specific prescription. Browse the full catalog at ronanrx.com/medications and ronanrx.com/peptides, or scan the codes at right for each index.

Medications

Peptides

MEDICATIONS (40)

Alpha-Lipoic Acid (ALA) — Antioxidant & mitochondrial
Coenzyme Q10 (CoQ10) — Antioxidant & mitochondrial
Glutathione — Antioxidant & mitochondrial
NAD+ / NMN — Antioxidant & mitochondrial
Compounded Topical Anesthetics (BLT, LET) — Dermatology
Topical Minoxidil — Dermatology
Topical Tretinoin — Dermatology
Compounded Magnesium — Energy & nutritional
Cyanocobalamin — Energy & nutritional
High-Dose Vitamin D — Energy & nutritional
Hydroxocobalamin — Energy & nutritional
Iron (Compounded) — Energy & nutritional
L-Carnitine — Energy & nutritional
Methylcobalamin (B12) — Energy & nutritional
Methylfolate — Energy & nutritional
Anastrozole — Hormone optimization
Clomiphene & Enclomiphene — Hormone optimization
DHEA — Hormone optimization
Estradiol — Hormone optimization
Estriol — Hormone optimization
Human Chorionic Gonadotropin (HCG) — Hormone optimization
Pregnenolone — Hormone optimization
Progesterone — Hormone optimization
Testosterone — Hormone optimization
Compounded Metformin — Metabolic & weight
Compounded Semaglutide — Metabolic & weight
Compounded Tirzepatide — Metabolic & weight
Lipotropic Injection (MIC, MICC) — Metabolic & weight
Low-Dose Naltrexone (LDN) — Metabolic & weight
Naltrexone-Bupropion Combination — Metabolic & weight
Topiramate — Metabolic & weight
Bremelanotide / PT-141 — Sexual health
Compounded Sildenafil — Sexual health
Compounded Tadalafil — Sexual health
Trimix Injection — Sexual health
Compounded Gabapentin — Sleep & recovery
Compounded Melatonin — Sleep & recovery
Compounded T3 (Liothyronine) — Thyroid
Compounded T3/T4 Combinations — Thyroid
Compounded T4 (Levothyroxine) — Thyroid

PEPTIDES (21)

Sermorelin — Available now

Tesamorelin — Available now

AOD-9604 — Growth-hormone axis (under FDA review)

CJC-1295 — Growth-hormone axis (under FDA review)

GHRP-2 / GHRP-6 — Growth-hormone axis (under FDA review)

Hexarelin — Growth-hormone axis (under FDA review)

Ipamorelin — Growth-hormone axis (under FDA review)

MK-677 / Ibutamoren — Growth-hormone axis (under FDA review)

5-Amino 1MQ — Metabolic & longevity (under FDA review)

Epitalon / Epithalon — Metabolic & longevity (under FDA review)

MOTS-C — Metabolic & longevity (under FDA review)

Thymosin Alpha-1 / Thymalin — Metabolic & longevity (under FDA review)

DSIP, Delta Sleep-Inducing Peptide — Neuro & cognitive (under FDA review)

Selank — Neuro & cognitive (under FDA review)

Semax — Neuro & cognitive (under FDA review)

Vasoactive Intestinal Peptide (VIP) — Neuro & cognitive (under FDA review)

BPC-157 — Tissue repair (under FDA review)

KPV — Tissue repair (under FDA review)

LL-37 — Tissue repair (under FDA review)

Pentadeca Arginate (PDA) — Tissue repair (under FDA review)

TB-500 / Thymosin Beta-4 — Tissue repair (under FDA review)